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Discounting the value of safety: Effects of perceived risk and effort

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Abstract

Introduction—Although falls from heights remain the most prevalent cause of fatalities in the construction industry, factors impacting safety-related choices associated with work at heights are not completely understood. Better tools are needed to identify and study the factors influencing safety-related choices and decision making.

Method—Using a computer-based task within a behavioral economics paradigm, college students were presented a choice between two hypothetical scenarios that differed in working height and effort associated with retrieving and donning a safety harness. Participants were instructed to choose the scenario in which they were more likely to wear the safety harness. Based on choice patterns, switch points were identified, indicating when the perceived risk in both scenarios was equivalent.

Results—Switch points were a systematic function of working height and effort, and the quantified relation between perceived risk and effort was described well by a hyperbolic equation.

Conclusion—Choice patterns revealed that the perceived risk of working at heights decreased as the effort to retrieve and don a safety harness increased.

Impact on industry—Results contribute to the development of computer-based procedure for assessing risk discounting within a behavioral economics framework. Such a procedure can be used as a research tool to study factors that influence safety-related decision making with a goal of informing more effective prevention and intervention strategies.

Keywords

Behavioral economics; Risk assessment; Risk discounting; Decision making; Construction

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Author note

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1. Introduction

Occupational safety professionals and researchers have long sought a greater understanding of the factors that influence safety-related behavior in the workplace. It has been particularly challenging to accurately predict or influence behavior at the moment workers face hazards or risks (Carrillo, 2011; McLain & Jarrell, 2007; Olson, Grossheusch, Schmidt, Gray, & Wipfli, 2009; Reynolds & Shiffbauer, 2004). For example, consider a construction worker faced with the task of working on a two-story elevated platform. The elevation clearly possesses a risk of falling, and yet it is uncertain that a worker in that situation will always take necessary and adequate precautions to prevent a fall. Despite widespread attention to the problem and advances in fall protection technology, falls from heights remain a leading cause of fatalities in the construction industry (Bureau of Labor Statistics, 2011).

According to BLS (2011), the construction industry had the highest number of yearly fatal work injuries in 2010; approximately one out of every six workers fatally injured in that year was a construction worker. Falls from heights accounted for 34% of all construction fatalities in 2010 making falls the number one fatality category that year. The magnitude and persistence of the problem suggest that our understanding of root causes is not sufficiently complete, but a consistent finding is that many falls can be attributed to a lack or improper use of adequate fall protection (Cattledge, Hendricks, & Stanevich, 1996; Kines, 2002). Studies show that risky choices leading to these injuries and deaths cannot be attributed simply to a lack of awareness or training (Kines, 2002; Lipscomb, Dale, Kaskutas, Sherman-Voellinger, & Evanoff, 2008). Many different factors have been shown to influence construction workers' decisions and behavior, including the presence of workplace barriers to safety performance (Gershon et al., 2000), and production pressures (Lipscomb et al., 2008).

A greater understanding of these factors and the various conditions under which these factors exert influence over safety-related decision making in construction and other high risk industries would lead to more effective prevention strategies. Toward that end, the development of a simple and reliable method for quantifying the *relative* influence of various safety-related factors in human decision making would be useful for basic and applied research. Fortunately, such a method may already exist in a common experimental approach used in behavioral economics to study human choice and decision-making.

1.1. Delay discounting

Delay discounting occurs when an individual prefers an immediate smaller reward to a delayed larger reward (Rachlin & Green, 1972). A common research method for assessing an individual's preference for immediate, smaller rewards involves presenting the individual with a series of trials in which they are asked to choose one of two different outcomes with the greater subjective value. The value of the outcome is influenced by the two reward parameters—magnitude and delay. In the typical procedure, an individual's pattern of choices is assessed across many trials in which reward magnitude and delay are parametrically and systematically varied between the outcomes. An indifference point (e.g., $1000 delivered in 2 months is equivalent to $750 delivered immediately) is then determined for each magnitude of the delayed reward. The resulting pattern of indifference points across delay values can be fit with mathematical utility functions that describe the relative influence of reward magnitude and delay on the individuals' choices. Using this basic approach, Mazur (1987) proposed that the rate of delay discounting can be expressed with a hyperbolic function

$$V = A/(1 + kD), \quad (1)$$

where *V* is the subjective value of the reward, *A* is the amount of a reward, *k* is the parameter that describes the rate of discounting, and *D* is the delay to the reward. The resulting function is a negatively decelerating curve, illustrating the robust finding that change in discounting is most rapid when delay values are small. Some key findings in the delay discounting literature are that rates of discounting can differ across individuals (e.g., Odum & Baumann, 2010), and high rates of discounting are presumed to reflect impulsive behavior (Bickel & Marsch, 2001; Reynolds, Ortengren, Richards, & de Wit, 2006). Rates of discounting can also vary for the same individual across situations (Odum & Baumann, 2010) and across different kinds of rewards (Odum & Rainaud, 2003).

In addition to reward delay, researchers have studied other factors affecting the value of a reward including its probability of occurrence (Rachlin, Raineri, & Cross, 1991) and the effort associated with obtaining it (Mitchell, 1999, 2004). Indeed, a large body of empirical research in behavioral economics shows that discounting of delay, probability, or effort provides explanatory accounts of risky choices across wide-ranging topics such as drug abuse and dependency (de Wit, 2009), personal finance (Hamilton & Potenza, 2012), diet (Appelhans et al., 2011), and gambling (Dixon, Marley, & Jacobs, 2003) to name a few.

1.2. Effort and risk discounting in safety

The general behavioral economics approach may be used effectively to study safety-related risk and the factors associated with safety-related decisions. Indeed, a conceptual link between delay-discounting and risk taking in occupational settings has been proposed previously (Normand, 2005; Reynolds & Shiffbauer, 2004), but to date this link has not been investigated empirically.

For the purpose of exploring the applicability and utility of conceptualizing safety-related decision making within a behavioral economics paradigm, a computer-based procedure was developed as a research tool to present individuals a series of hypothetical scenarios involving safety-related choices. The scenarios describe a common construction-related task in which a demand for *productivity* is pitted against the required *effort* to perform the work safely. In our novel application, an individual is asked to imagine working on a roof at a specific height, and that a specific amount of effort is required to retrieve and don a safety harness prior to initiating the work. In each trial, the individual is presented with a choice between two types of scenarios. In the *standard* (STD) scenario, height and effort remain constant across trials. In the *adjusting* (ADJ) scenario, height varies parametrically across trials and effort varies parametrically across blocks of trials. In each of several trials, the individual is asked to choose the scenario in which they would be *more likely* to retrieve and don the safety harness. On the basis of the resultant choice patterns between STD and ADJ scenarios across the trials, a *switch point* can be calculated to quantify the relative influence of height and effort on individuals' choices, and can be conceptualized as when the participants' perception of risk in the STD and ADJ scenarios are equivalent. Furthermore, a mathematical function can be fitted to the switch points across different height and effort conditions to describe the magnitude and rate of *risk discounting*. If this approach is found to be reliable and valid, then the general procedure can be used as a research tool to better understand the choices and decision-making processes of workers in other safety-related scenarios.

1.3. Study objectives

Thus the main objective of this study was to evaluate a novel risk discounting procedure as a potential research tool to quantify individual's pattern of choices in a safety-related scenario as a function of perceived risk and response effort. To demonstrate the utility of the approach, choice patterns were obtained from individuals across multiple trial blocks in which the working height in the STD scenario was set at either 20 ft or 40 ft and the effort to retrieve and don the safety harness in the ADJ scenario was either 5 min, 10 min, 15 min, or 25 min. These values represent common conditions encountered at construction sites. It was hypothesized that switch points are a function of the STD height (i.e., perceived risk) and time required to retrieve and don the safety harness. It was further hypothesized that the mathematical functions that describe the rate of risk discounting in the present scenarios are hyperbolic and consistent with hyperbolic patterns of discounting seen with other frequently studied behavioral phenomena.

2. Method

2.1. Participants

Twenty-one students were recruited from an undergraduate learning course at a university in the Mid-Atlantic area. All participants received extra class credit in exchange for their participation. Data from 11 participants (3 males and 8 females) were included in the final analyses. Participants were excluded from the statistical analyses because their choice patterns indicated that they might have misunderstood the procedure. This was evidenced in one of two ways: (1) participants chose the same scenario exclusively and throughout an entire block of trials, or (2) participants chose the scenarios without any consistency. Ten participants showed one of these types of responding in at least one block of trials and, as a result, all data from these participants were excluded. All procedures were approved by the Institutional Review Boards of both affiliated institutions.

2.2. Setting and materials

Instructions and all experimental trials were presented on a laptop computer running E-Prime 2.0 (Psychology Software Tools, 2008). Each participant completed one approximately 45-min session alone in a quiet room.

2.3. Instructions and orientation

The session began with the participant seated in front of the computer. The following instructions were presented on the monitor:

> "Welcome to our occupational risk-taking study! Before you start the study, we will take you through detailed instructions on how to respond. You will be asked a number of questions. Each question will involve a choice between two options. One option will be on the right, and one option on the left. Please press the '1' key on the keyboard if you select the option on the LEFT. Please press the '2' key on the keyboard if you select the option on the RIGHT."

A sample trial depicting two work scenarios was then displayed on the monitor for 13 s (see Fig. 1). Each scenario displayed the working height (ft) and the effort (min) to retrieve and don a safety harness. To further show the effort in context, a picture was also depicted with each scenario to show a safety harness in a corresponding state of disarray or entanglement. After the sample trial, the following instructions were presented:

> "In the following slides, you will be asked to imagine that you are working on the roof of a building. The distance from the roof to the ground will change every time you press a button."

To further orient the participants to the hypothetical scenarios, a series of seven photographs was then presented consecutively. The pictures were taken at a construction site and each picture used the same downward view. The series of pictures showed views from a height of 70 ft to 10 ft in descending increments of 10 ft. Each photograph, which was displayed for 10 s, was subtitled with the following text:

> "This is the view from a roof that is approximately *x* ft from the ground, if you are looking straight down."

Following the presentation of all photographs, participants completed an additional 21 sample trials (similar to Fig. 1). Each *sample* trial contained two types of scenarios: *standard* (STD) and *adjusting* (ADJ). Effort to retrieve and don the safety harness was 3 min in all STD scenarios (*STD effort*) and 16 min in all ADJ scenarios (*ADJ effort*). Working height was fixed at 25 ft in the STD scenarios (*STD height*); working height varied from 20 ft to 70 ft in the ADJ scenarios (*ADJ height*). Participants were instructed to select the scenario in which they would be more likely to wear a safety harness by pressing '1' on the keyboard for the scenario on the left and '2' for the scenario on the right. Each selection immediately initiated the next trial. There was no time limit for making a response. Throughout the orientation phase, participants were asked whether they had any questions about the procedure.

2.4. Experimental assessment

The assessment began after the orientation phase. Participants completed trials presented across eight blocks of 51 trials each. Thus each participant completed a total of 408 trials. Similar to sample trials, each assessment trial presented a choice between a STD and ADJ scenarios. The STD scenarios appeared on the left side of the monitor in one half of the trial blocks and the right side in the other half. ADJ scenarios appeared on the opposite side of STD scenarios in each trial. The actual height and effort values described in the scenarios presented across and within trial blocks are shown in Table 1.

2.4.1. STD height—
STD height was 20 ft in one half of the trial blocks and 40 ft in the other half. The STD height of 20 ft was selected because it is the lowest height likely to be perceived as unsafe by most individuals in the general population. The additional STD height of 40 ft was selected because it was expected to be perceived as a much greater risk. Participants were randomly assigned to one of two sequences. In one sequence (n = 7), STD height was 20 ft in Blocks 1–4 and 40 ft in Blocks 5–8. In the other sequence (n = 4), STD height was 40 ft in Blocks 1–4 and 20 ft in Blocks 5–8.

2.4.2. ADJ height—
ADJ heights were presented in a random sequence within each block of trials. In trial blocks with a STD height of 20 ft, ADJ heights were odd values from 11 ft to 111 ft. In trial blocks with a STD height of 40 ft, ADJ heights were odd values from 31 ft to 131 ft. Each ADJ height in the range was presented only once in the block of 51 trials.

2.4.3. STD and ADJ efforts—
STD effort was 1 min in all trials and in all trial blocks. ADJ effort varied across trial blocks. Effort values were 5 min, 15 min, 25 min, or 50 min across the four trial blocks with a STD height of 20 ft and across the four trials blocks with a STD height of 40 ft.

2.5. Dependent variables

Analysis of the choice patterns across the trials in each block yielded a switch point, which indicated when the participants perceived the risk in the STD and ADJ scenarios as equivalent. To determine these switch points, trials in a block were first sorted by ascending height in the ADJ scenario. On the basis of the sorted ADJ height values, choice patterns in which participants switched their preference from the STD scenario to the ADJ scenario only once in a trial block, yielded a *single* switch point. A single switch point was the height value associated with the ADJ scenario at which a participant stopped choosing the STD scenario on successive trials and started consistently choosing the ADJ scenario without ever choosing the STD scenario again. Because only odd ADJ height values were used, the actual switch point recorded was the mid value. For example, if a participant's choices switched between 35 ft and 37 ft, 36 ft was recorded as the single switch point.

Choice patterns in which preference switched from the STD scenario to ADJ scenario more than once in a trial block yielded an *interpolated* switch point. The interpolated switch point was derived from the frequency of choosing the ADJ scenario between the lower and the upper limits. For example, if the lower limit was 28 ft, the upper limit was 42 ft, and the participant chose the ADJ scenario during four of the eight intervening trials, then the interpolated switch point would be calculated as follows: 28 ft + (4 trials × 2 ft) = 36 ft (see Table 2 for an example). The lower limit was the height value associated with the ADJ scenario at which a participant stopped consistently choosing the STD scenario and started choosing the ADJ scenario. For example, in Table 2 the lower limit was identified as 28 ft, because the participant consistently chose the STD scenario over the ADJ scenario in trials up to a height of 27 ft and then switched responding to the ADJ scenario in the trial with a height of 29 ft. The upper limit was the height value associated with the ADJ scenario at which a participant stopped choosing the STD scenario and started consistently choosing the ADJ scenario. For example, in Table 2 the upper limit was identified as 42 ft, because the participant chose the STD scenario over the ADJ scenario in the trial with a height of 41 ft and then switched responding to the ADJ scenario in all trials with a height of 43 ft and greater.

2.6. Reliability of switch-point determinations

Because of the possibility of human error in identifying switch points, limits, and outliers, two independent observers were used. Single switch points were identified in 68% (60/88) of all trial blocks. Initially, the observers agreed on 59% (68/166) of the switch points and limits. A third observer was invited to help resolve the discrepancies. Among the discrepancies, the third observer agreed with one of the two initial observers on all switch points and limits except for three. Thus at least two out of three observers agreed on 97% (113/116) of the time. The remaining three disagreements were resolved by consensus.

2.7. Data analysis

Single and interpolated switch points obtained from all trial blocks were considered equivalent for data-analytic purposes. Single and interpolated switch points (hereafter *switch points*) were hence combined in subsequent analyses. Mean switch points for each trial block were then calculated and analyzed by STD height and effort. Normalized switch points were calculated for each trial block by subtracting the STD height from the switch point in each block of trials. This calculation normalized the switch point across levels of STD height. To evaluate the effects of different STD heights across the multiple ADJ effort values, repeated measures ANOVAs were performed using SigmaPlot (v. 11; San Jose, CA). Simple effects and pairwise comparisons were evaluated with the Holm–Sidak method using SigmaPlot. Differences were considered significant when $p < .05$. Effect sizes using eta squared (η^2) were considered small (0.01), medium (0.06), and large (0.14) (Cohen, 1988).

3. Results

3.1. Switch points

3.1.1. Effects of STD height—Fig. 2 (top panel) shows mean switch points as a function of STD height and ADJ effort. A two-way repeated measures ANOVA (2 STD height × 4 ADJ effort) revealed no interaction between STD height and ADJ effort [$F(3, 30) = 2.191$, $p = .110$, $\eta = 0.004$]. The ANOVA revealed a main effect of STD height [$F(1, 30) = 72.15$, $p < .001$, $\eta^2 = 0.17$]. Switch points associated with a STD height of 40 ft were significantly greater than switch points associated with a STD height of 20 ft. Pairwise comparisons of switch points within each level of ADJ effort revealed that switch points associated with STD heights of 20 ft and 40 ft were significantly different at each level of ADJ effort. Table 3 summarizes the results of the pairwise comparisons.

3.1.2. Effects of ADJ effort—The two-way repeated measures ANOVA also revealed a main effect of ADJ effort [$F(3, 30) = 8.14$, $p < .001$, $\eta^2 = 0.11$]. As Fig. 2 (top panel) illustrates, mean switch points increased as ADJ effort increased. Simple effects analysis revealed that in trials with a STD height of 20 ft, the mean switch point was significantly greater when ADJ effort was 50 min than when ADJ effort was 25 min, 15 min, or 5 min. In trials with a STD height of 40 ft, the mean switch point was significantly greater when ADJ effort was 50 min than when ADJ effort was 15 min or 5 min.

3.2. Switch points normalized to STD height

Fig. 2 (bottom panel) shows the switch points normalized to STD height. Despite the visual difference between switch points across levels of STD height, the two-way repeated measures ANOVA (2 STD height × 4 ADJ effort) revealed no interaction between STD height and ADJ effort [$F(3, 30) = 2.191$, $p = .110$, $\eta = 0.004$]. The ANOVA revealed no significant main effect of STD height on the normalized switch points [$F(1, 30) = 2.50$, $p = .15$, $\eta^2 = 0.01$]. Analyses of simple effects showed that when the effort was 50 min, the mean switch point was greater when STD height was 20 ft than when it was 40 ft. No significant differences were found at other effort levels.

3.3. Hyperbolic equation fitting

In hyperbolic delay discounting, the value of a reward is a function of both amount and delay; for any given amount, the value of a reward decreases with increases in delay according to a negatively decelerated function. In the present safety scenarios, the subjective *value* of safety can be conceptualized as being a function of the amount of perceived risk and effort. As working height increased in the scenarios, increases in effort required to retrieve and don the safety harness had diminishing effects on perceived risk. The relation was found to be described well by a positively decelerated hyperbolic function:

$$R=H+E/(1+kE), \quad (2)$$

where *R* is the perceived *risk* or equivalent working height measured in feet, *H* is the STD working height, *E* is the effort associated with retrieving the safety harness, and *k* is the rate of effort discounting. Fig. 3 shows the hyperbolic relation between mean switch points and ADJ effort. The hyperbolic functions across all ADJ effort values fit well when STD heights were 20 ft ($R^2 = 0.9679$, $p = .002$) and 40 ft ($R^2 = 0.9865$, $p = .001$.). As Fig. 3 shows, the rate of risk discounting was greater when the STD height was 40 ft ($k = 0.25$) than when STD height was 20 ft ($k = 0.15$).

3.4. Generality of choice patterns across participants

Fig. 4 displays the proportion of participants choosing ADJ scenario over STD scenario across the entire range of height values in ADJ. The resultant gradients were plotted as a function of effort within each panel and as a function of STD height across panels (20 ft in top panel and 40 ft in bottom panel). The gradients show the generality of these effects as well as the range of switch points obtained from participants. Although single switch points were identified in most trial blocks, the figure shows that the location of these switch points along the range of ADJ height values varied across participants. For example, as the ADJ height increased, an increasing proportion of participants chose the ADJ scenario as the one in which they were more likely to retrieve and don the safety harness, but the preference reversals did not occur for some participants until the highest heights were presented in the ADJ scenario. Furthermore, the increase in effort associated with retrieving and donning the safety harness appeared to exacerbate inter-subject variability in switch points. This is illustrated by the shift of the gradients down and to the right as effort increased from 5 min to 50 min. Interestingly, the magnitude of this shift appeared to be greater when the STD height was 20 ft than when it was 40 ft, perhaps corresponding to the difference in perceived risk.

4. Discussion

Our findings support the notion that increased effort associated with safety behavior contributes to riskier decision making. Using a common construction scenario in our procedure, the perceived risk of working at heights decreased as the effort to retrieve and don a safety harness increased. This finding is consistent with earlier research on effort discounting of rewards (e.g., Mitchell, 1999, 2004). Furthermore, a hyperbolic equation also provided a good fit for the choice patterns, as predicted, suggesting that discounting of occupational risk as a function of response effort may have similar characteristics as discounting of rewards tempered by delay, low probability, and high effort as reported in the behavioral economics literature. However, it should be noted that the functions we obtained were positively decelerated, as opposed to the negatively accelerated functions typically observed in delay discounting research. This difference can be accounted for by the arrangement of standard and adjusting parameters. An alternative procedure in which the fixed and adjusting parameters appear in both scenarios (cf. Richards, Mitchell, de Wit, & Seiden, 1997) would be expected to produce a negatively accelerated function, but the overall conclusions would not change. A disadvantage of this alternative arrangement of scenarios would have been a restricted range of possible switch points in the STD 20 ft condition (i.e., switch points would have to be less than 20 ft).

A possible limitation of the present study and similar delay discounting research is the use of hypothetical outcomes. Choice patterns resulting from scenarios that are real or actually experienced may be quite different than those obtained in a laboratory setting using contrived procedures. However, empirical evidence supports an opposite conclusion, at least in the context of discounting research using similar experimental methods. For example, researchers have found that patterns of discounting are quite similar when using either delayed hypothetical or real outcomes (Madden, Begotka, Raiff, & Kastern, 2003; Madden et al., 2004).

Although the pattern of choices obtained in this study can be expected to occur in the real world, the pattern of choices varied across participants. Some participants always chose the response option associated with greater working height, regardless of effort. It is not clear whether these participants were influenced by perceived demand characteristics of the research setting (i.e., desired to appear safe), were simply risk-averse, or were confused by the instructions. Considering that the choice patterns of other participants (e.g., those were excluded from analysis) were not interpretable, additional studies are needed to differentiate specific aspects of the procedure that may be confusing from those that are sensitive to important inter subject differences in human decision making.

It is also possible that many of our participants, which were recruited from a pool of undergraduate psychology students, did not have real-world experience working at heights.

Future studies should assess each participant's self-reported explanations of their choices to reveal other extraneous variables for idiosyncratic patterns of choice. This additional assessment of participants should lead to a refinement of the procedures. For example, a lower STD height of 6 ft (i.e., the height that triggers a fall protection requirement by OSHA) can be expected to yield greater discounting of risk across all levels of effort. Future research using fall risk or other safety scenarios should assess specific levels of factors that are more commonly encountered in the work place, those that are associated with high incidences of injury or death, or those in which the factors that influence decision making are not fully understood. Studies should also be conducted with different populations including workers in different jobs or industries to further expand the descriptive and predictive validity of the method. Also relevant would be studies that investigate whether safety choices are affected by other factors related to safety-related decision making such as the perceived probability of injury or illness, delay to onset of injury or illness, and cost of personal protective equipment, to name few. Finally, studies should evaluate experimentally how lifestyle factors such as fatigue (Lombardi, Folkard, Willetts, & Smith, 2010), caffeine (Smith, 2005), and alcohol use (Konstantinidis et al., 2011; Liu & Ho, 2010) affect safety choices.

5. Conclusions

Better tools are needed to identify and study the factors influencing safety-related choices and decision making. Using a computer-based task, participants were instructed to choose between two hypothetical scenarios that differed in working height and effort associated with retrieving and donning a safety harness. Participants were instructed to choose the scenario in which they were more likely to wear the safety harness. Resulting choice patterns revealed that the perceived risk of working at heights decreased as the effort to retrieve and don a safety harness increased. As workers' health and safety depend in part on appropriate choices in risky situations, the application of a behavioral economics paradigm appears to reveal fundamental insights that could lead to more effective prevention and intervention strategies.

6. Impact on industry

The development of a reliable and valid procedure for assessing risk discounting within a behavioral economics framework will provide a valuable tool for safety researchers. Such a tool will help to identify choice patterns of individual workers or groups of workers across many different variables and conditions involving hazards and risks. On the basis of these findings, safety training or other safety interventions could then be targeted directly towards removing the barriers or enhancing the facilitators of safer choices. Indeed, the success of behavioral economics applications in other areas of public health practice suggests that a similar approach in the field of occupational safety would have considerable utility.

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Biographies

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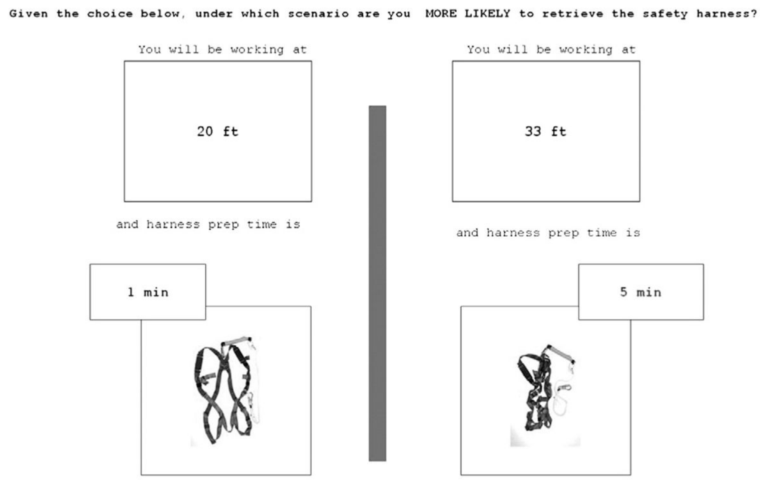

Fig. 1.
Sample trial showing STD scenario on left side of screen and ADJ scenario on right side of screen.

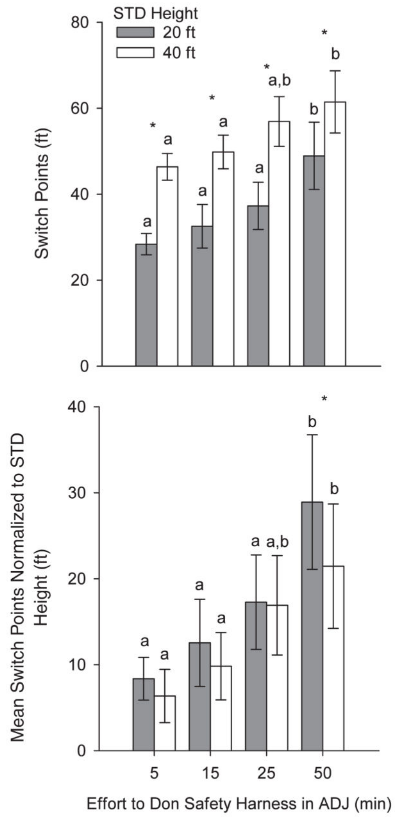

Fig. 2.

Panel A (top) shows the mean switch points (height in the ADJ scenario associated with a preference reversal). Panel B (bottom) shows the mean switch points normalized to STD. An asterisk (*) above bar groups symbolizes a significant difference between mean switch points across levels of STD height (20 ft vs. 40 ft), whereas shared letters *a* or *b* above the bars denote that mean switch points are not significantly different across levels of ADJ effort. Error bars denote SEM.

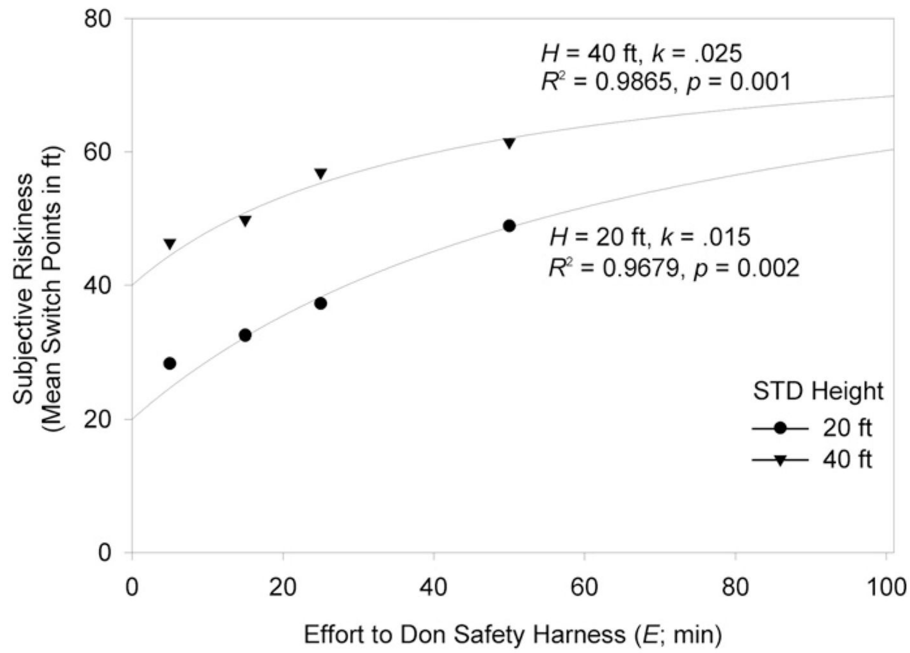

Fig. 3.

Hyperbolic risk discount functions resulting from the equation $R = H + E / (1 + kE)$, where H is the standard or reference height, E is the effort to retrieve and don the safety harness, and k is the rate of risk discounting. Functions are shown for the effects of effort on the subjective riskiness of working at 20 ft (lower plot) and 40 ft (upper plot). Subjective riskiness represents the height in the ADJ scenario that is perceived to be equivalent to the height STD scenario discounted by the effort required to don the safety harness in the ADJ scenario.

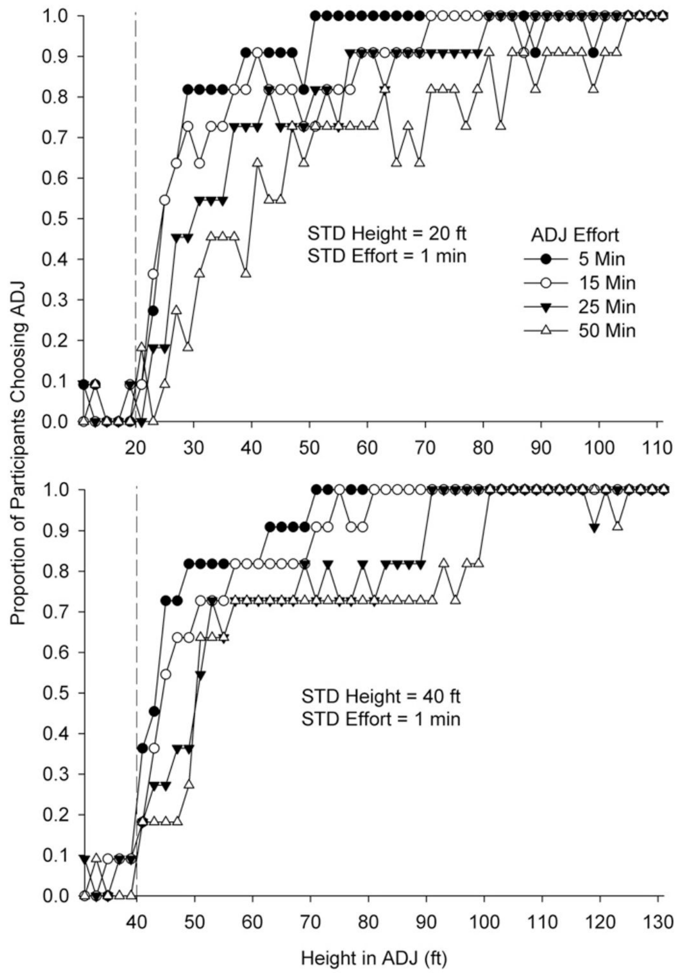

Fig. 4.

Mean proportion of participants choosing the ADJ scenarios as function of ADJ height and ADJ effort when compared with STD effort of 1 min and STD height of 20 ft (top panel) and 40 ft (bottom panel). The dashed vertical line indicates the STD height. The plots show the generality of the choice patterns among the participants.

Table 1

Summary of height and effort values of the standard (STD) and adjusting (ADJ) scenarios across trial blocks.

Scenario parameters	Trial blocks[a]							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
STD height (ft)	20	20	20	20	40	40	40	40
STD effort (min)	1	1	1	1	1	1	1	1
ADJ height (range in ft)[b]	11–111	11–111	11–111	11–111	31–131	31–131	31–131	31–131
ADJ effort (min)	5	15	25	50	5	15	25	50

[a] Sequence of trial blocks was counterbalanced across participants by STD height.

[b] ADJ heights were odd values in the range; sequence was random across the 51 trials in each block.

Table 2

Sample data in a block of trials showing lower limit, upper limit, and switch point.

Trial number	STD effort (min)	STD height (ft)	ADJ effort (min)	ADJ height (ft)		Key press (1 = STD, 2 = ADJ)
10	1	20	5	11		1
21	1	20	5	13		1
32	1	20	5	15		1
50	1	20	5	17		1
43	1	20	5	19		1
25	1	20	5	21		1
14	1	20	5	23		1
20	1	20	5	25	28 ft, lower	1
3	1	20	5	27	limit	1
39	1	20	5	29		2
44	1	20	5	31	36 ft,	1
33	1	20	5	33	interpolated	1
26	1	20	5	35	switch point	1
7	1	20	5	37		2
31	1	20	5	39	42 ft, upper	2
40	1	20	5	41	limit	1
11	1	20	5	43		2
42	1	20	5	45		2
49	1	20	5	47		2
34	1	20	5	49		2
15	1	20	5	51		2
4	1	20	5	53		2
24	1	20	5	55		2
30	1	20	5	57		2
9	1	20	5	59		2
1	1	20	5	61		2
22	1	20	5	63		2
35	1	20	5	65		2
13	1	20	5	67		2
27	1	20	5	69		2
16	1	20	5	71		2
38	1	20	5	73		2
48	1	20	5	75		2
45	1	20	5	77		2
29	1	20	5	79		2
19	1	20	5	81		2
51	1	20	5	83		2
41	1	20	5	85		2
5	1	20	5	87	Outlier	1
18	1	20	5	89		2
8	1	20	5	91		2
12	1	20	5	93		2
47	1	20	5	95		2
36	1	20	5	97		2
23	1	20	5	99		2
2	1	20	5	101		2
46	1	20	5	103		2
37	1	20	5	105		2
28	1	20	5	107		2
17	1	20	5	109		2
6	1	20	5	111		2

Table 3

Pairwise comparisons of effects.

Sources	df	*t*	*p*	r^2	DM
Switch points					
STD height 20 ft vs. 40 ft					
5 min	10	6.75	<0.001**	0.8200	18.00
15 min	10	6.48	<0.001**	0.8075	117.27
25 min	10	7.36	<0.001**	0.8443	19.64
50 min	10	4.70	<0.001**	0.6887	12.55
ADJ effort 50 min vs. 5 min					
STD 20 ft	10	4.99	<0.001**	0.7138	20.55
STD 40 ft	10	3.67	0.004	0.5736	15.09
ADJ effort 50 min vs. 15 min					
STD 20 ft	10	3.98	0.001**	0.6128	16.36
STD 40 ft	10	2.83	0.036*	0.4444	11.64
ADJ effort 50 min vs. 25 min					
STD 20 ft	10	2.83	0.29*	0.4444	11.64
STD 40 ft	10	1.11	0.476	0.1088	4.55
ADJ effort 25 min vs. 5 min					
STD 20 ft	10	2.17	0.106	0.3193	8.91
STD 40 ft	10	2.56	0.056	0.3965	10.55
ADJ effort 25 min vs. 15 min					
STD 20 ft	10	1.15	0.449	0.1166	4.73
STD 40 ft	10	1.72	0.253	0.2291	7.09
ADJ effort 15 min vs. 5 min					
STD 20 ft	10	1.02	0.316	0.0936	4.18
STD 40 ft	10	0.84	0.406	0.0659	3.46
Switch points normalized to STD height					
STD height 20 ft vs. 40 ft					
5 min	10	0.75	0.460	0.0533	2.00

Sources	df	t	p	r^2	DM
15 min	10	1.02	0.316	0.0947	2.73
25 min	10	0.14	0.893	0.0019	0.36
50 min	10	2.80	0.009	0.4386	7.46

Note. According to Cohen (1988), the categories of effect size for r^2 are the following: small = 0.01, medium = 0.09, and large = 0.25. DM = difference in means.

* $p < 0.05$.

** $p < 0.01$.